THE ANIE

A math assessment tool that reveals learning and informs teaching

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Hawker Brownlow
EDUCATION

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Introduction: Positive Results

Question: What do you get when you multiply two negative numbers? For example, what is the value of n?

$$-2 \times -4 = n$$

The product is +8. That's an easy question. What if we asked you to explain how you arrived at the answer? In other words, why is the product of two negative numbers positive? Is that still an easy question?

Many of you likely responded, "That's the rule!" Indeed, the rule states that two negatives make a positive, but why is that so?

Can you think of a real life situation that uses the rule about the product of two negative numbers? Perhaps even a hypothetical unworldly situation?

That is a more difficult task. It took some time for the people we asked to develop scenarios that make sense in the real world. It would have been much easier to apply the algorithmic rule.

> Every day Sally stops at the store and buys a health bar for $2 (–2 dollars).
> How much more money did she have 4 days ago (–4 days)?
> The answer is +$8!

For this situation, we considered the transactions from Sally's perspective in order to create negative variables. We assigned the cost of the health bar as one negative variable. The number of times she bought a health bar in the past is the other negative variable. She purchases a bar each day, so we can be confident in using that variable in the equation. Since we represented Sally's action of spending money as a negative number, we were able to assign a positive value to the money she had in her hand. So, how much more money did she have 4 days ago? $-2 \times -4 = 8$. Four days ago, Sally had $8.

Now that we have described one real life situation, you can make your own connections to the math and can likely create several different situations to illustrate the math concept.

Our goal is for all math learning outcomes to be taught with real world applications. We know that students need to actively engage in making meaning for themselves in order to facilitate real learning. They need to connect the math concepts they are learning to their own lives.

In order to help teachers achieve this goal, we developed a tool we call the Assessment of Numeracy in Education (ANIE). The ANIE is simple, powerful and relevant. The tool can be easily used in all math classrooms to conduct ongoing assessment. The ANIE is accessible to all teachers whether they are generalists or math specialists. Teachers have told us that it takes very little time to understand what the ANIE can do. The tool is powerful because it helps teachers identify their students' understanding and lack of understanding of a concept or a procedure, and build instruction to support gaps in learning.

We believe that this book can change the way that teachers think about teaching math and by extension, how students learn math. By using the ANIE for continuous assessment, teachers can help their students develop habits of deeper thinking about math. What we are asserting is not rocket science, but it could lead to it. Our assessment tool and intervention strategies may seem simple and yet we have seen our approach revolutionize the way that math is taught and learned.

In our book, we will explain each component of the assessment tool, how to introduce the ANIE to students, how to grade and interpret the results, and how to integrate the ANIE in the classroom. Throughout we will discuss some of our experience with using the ANIE to improve learning and test scores, which have been replicated in different schools with a diversity of students. We believe that using our assessment tool results in radical improvements in learning for students, classrooms and schools. We are writing this book because we want you to try teaching math using the ANIE. We often observe teachers who become re-energized and students who get excited about the improvements they are making in their math abilities. Some students even identify math as their favorite subject! We want you to succeed at a level that you may not yet believe is possible. If that sounds like a fantasy, we understand— sometimes we still do not quite believe it ourselves.

We believe that by combining our approach and the ANIE, you can facilitate this kind of teaching and learning in your classroom.

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The ANIE

The ANIE is a one-page assessment of students' understanding of a single learning outcome or standard. The ANIE is designed for students from Grades 1 to 12 and takes about 10 minutes to administer. Grading is relatively quick and most importantly, teachers can use the results to plan timely and targeted intervention.

The ANIE is unique because it is complex enough to assess conceptual and procedural understandings that align with performance standards and yet simple enough to use as a learning tool every day. Also, the ANIE allows students to use their own words to connect math with their own lives. Our tool reflects what we learned from the research about the language demands of math, and allows students to focus on the math without struggling with imposed language.

A Diagnostic Tool

The ANIE assesses several different aspects of a student's understanding of a math concept or procedure. For example, can students make a reasonable estimate? Can they explain their strategy? This helps teachers identify gaps in learning and where the gaps occur. Gaps in learning are not always apparent from the results of a traditional test requiring only a correct answer. Many students may be able to give a correct answer without a real understanding of the underlying concept or procedure. This strategy may work for a short time, but as the math concepts become more difficult, the gaps in learning become greater. Without intervention, students begin falling behind, which ultimately affects their grades, motivation and perhaps, self-esteem.

The ANIE helps teachers identify and then plan intervention to support students' gaps in learning. In some cases, intervention may take 15 minutes or less to clarify the missing piece of a concept.

We recommend using the ANIE as a form of continuous assessment to ensure that no students fall behind. In this way, teachers can identify problems quickly and intervene as soon as possible.

Effective assessment should reflect what students have learned from the instruction. The ANIE provides an opportunity for teachers to reflect on their teaching. For example, they might ask themselves:

- Have I built understanding by breaking down the math concept into sequential steps?

- When my students demonstrate understanding of a concept, am I ready to move them on?

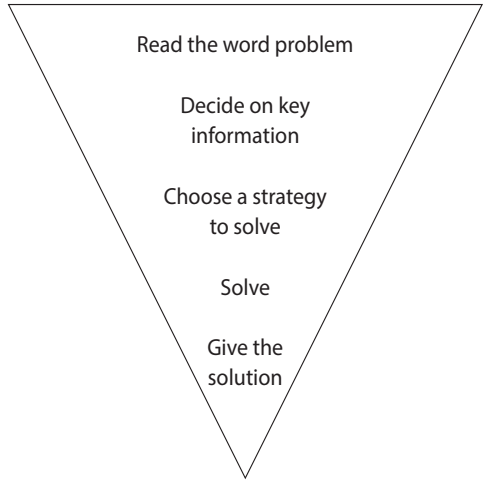
The ANIE also helps identify where students with no gaps might develop deeper understanding of a math concept and go beyond the expectations. Regularly asking students to think of different algorithms or visual approaches to represent a problem helps them create a habit of the mind—promoting a different mind set about math. It may be sufficient to get a correct answer but it is even better to be able to represent the answer in different ways. Regular use of the ANIE trains students to readily identify multiple solutions and approaches.

When we began using the ANIE in our classrooms, we were at first appalled by our students' low level of understanding of basic math concepts. We learned firsthand that once teachers move past the shock of where students truly are in their understanding of math, they can begin the real work of teaching students for learning.

Upside-Down Word Problem

To be successful in solving traditional word problems, students need to be able to read the problem, make sense of it, and decide what they need to do mathematically before they can attempt to solve it. Many students struggle with understanding and solving math word problems because they lack reading and comprehension skills. The language is often dense and the vocabulary may be unfamiliar. They may give up on trying to understand the meaning of the problem and perform a mathematical operation on numbers they see in the problem without understanding why or if doing so makes sense. In such cases, the language adds a level of complexity that prevents students from being able to focus on the math.

Traditional Word Problem



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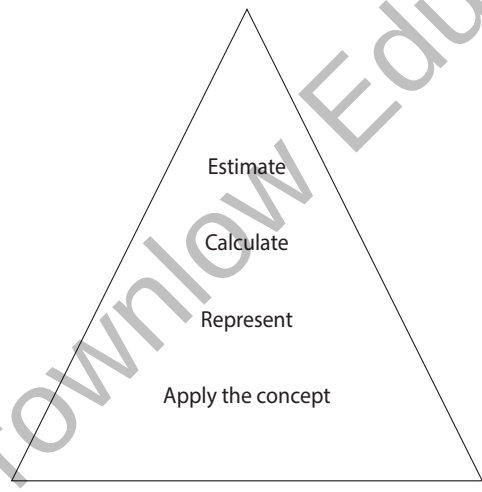
The ANIE turns the traditional model upside down by starting with a math question—not a word problem. By eliminating any language barriers, students can focus on the math and interact with the question using prior knowledge and their own words to explain their thinking. Then, students develop a word problem to mathematize a real life situation of their choice and in so doing, they demonstrate understanding of a math concept. The word problem comes from the students themselves, which promotes higher levels of cognition, engagement and long-term understanding (Van de Walle and Folk, 2008).

To be successful with the ANIE, students need to estimate a reasonable answer, calculate the answer, represent the question, and apply the concept to a real world situation by developing a word problem. Each step is described more fully later in the chapter.

The ANIE



Developing Doorway Questions

Imagine a series of connected rooms to represent a math curriculum. Each room represents a concept that students must understand before they can move to the next room. The key to opening the door to that room is demonstrating full understanding of the concept.

A doorway question represents a concept or outcome of a lesson or unit of study. When teachers plan how to teach and assess a concept, they need to break the concept into the skills and understandings needed for mastery. Also, the steps need to be taught in logical order. If a teacher fails to do this, skills that have not been taught may be inadvertently introduced in a doorway question. For example, suppose a class is working on how to add double-digit numbers. If students have not learned how to carry from the ones place value to the tens place value, the doorway question should not involve carrying.

So, $32 + 21 = n$ instead of $36 + 25 = n$.

It is crucial to identify the incremental skills needed to master a concept or learning outcome. By identifying these skills, teachers avoid assessing students on concepts for which they lack prerequisite skills.

Our research teachers tell us that they personally complete an ANIE for each doorway question they develop before assigning the ANIE to the class. Doing so gives teachers practice with a concept to improve instruction and it allows them to refine the questions that address the concept. It can also be very informative to develop multiple ways of representing a concept or different algorithmic approaches.

We advise teachers to assign an ANIE each time they complete their instruction for a learning outcome in order to assess what students understand or misunderstand. Completing ANIEs on a regular basis lets students become so familiar with its format that they can concentrate their efforts on the math question.

There is really no limit to the kinds of questions that teachers can create for an ANIE. Many learning outcomes or standards can be assessed including those from number sense, patterns and algebra, measurement and geometry.

$33 \times 5 = n$ $3x + 5 = 20$ $A = \pi r^2$
$r = 4$
Solve for A.

The ANIE Template

The ANIE gives students an opportunity to show their level of understanding of a concept or procedure in a variety of ways. The template includes these components:

- estimation
- calculation
- representation
- explanation
- application to real life
- reflection

The template is designed for students who can communicate their thinking in written form (typically Grade 3 onward). The ANIE Junior template for prewriters is provided in Chapter 2.